

AN ELIMINATION TYPE OF POKAYOKE- A GAME CHANGER TOOL IN THE PROPELLER SHAFT ASSEMBLY

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ABSTRACT

Monitoring the Industrial OEE (Overall Equipment Effectiveness) [3],[4] is now a day's a very essential concern for optimizing the use of the resources and tracking the efficiency of the manufacturing organization. To produce the goods with no errors is really a challenge in this era. Pokayoke [1] is a Japanese term; which means "Mistake Proofing" and most widely used in automotive industries to eliminate defect and possibility of producing the defective parts. "Elimination" is one of the type of the Pokayoke system; which is generally adopted to eliminate the possibility of the chance error during the operation. This tool is used in Propeller Shaft manufacturing organization; especially in Propeller Shaft assembly; resulting in the productivity optimization which is achieved more than 50%, another breakthrough is 20% saving in "rework" parts and 30% "Not ok" parts are saved out of the total propeller shafts considered for trial.

KEYWORDS: Productivity Optimization, Propeller Shaft Assembly & Mistake Proofing

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INTRODUCTION

For the propeller shaft assembly, this bearing needs to be assembled in the centre of the centre bearing kit. It's very difficult to hold and retain the bearing at its location with the rubber shield. In this regards, the bearing needs some additional outer shell for bearing holding purposes. The two halves of the retainers are pressed over the bearing just like the sandwich, bearing is in the middle of the assembly and the two halves are pressed with the hydraulic pressure.

Process Flow of Bearing Retainer Fitment Operation

The very common process of bearing retainer fitment operation; which is mostly adopted by the majority of the automotive propeller shaft manufacturing industry is given below.

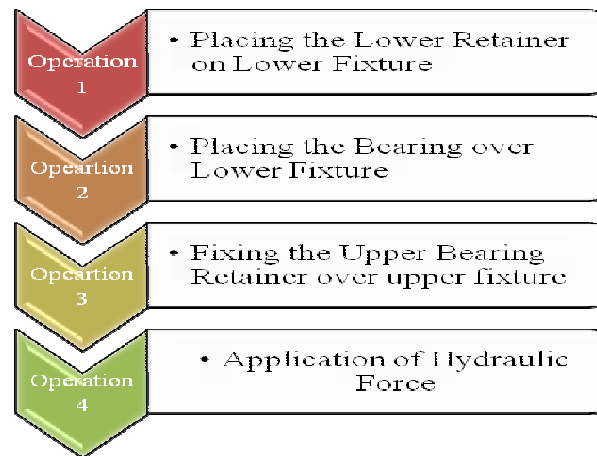


Figure 1: Process Flow of Bearing Retainer Fitment operation

The critical parameter here is to maintain the proper orientation of the two retainers, if the orientation is not as per the standard control plan, the assembly needs rework and once the retainer is used; it can't be re-used and it will be a source of waste. The name itself called as a retainer; which retains the bearing in the centre of the centre bearing kit.



Figure 2: Bearing Retainer Fitment Issue

The bearing retainer assembly; earlier it was a hectic job. The retainer firstly placed on the fixture; then the bearing is placed over the bottom retainer, after completing this set of the operations; the upper bearing retainer is fastened to the upper most part of the fixture. After that the trigger of the operation was initiated. In this way the bearing retainer assembly is being carried out.

Bearing Fitment Data Collection

The bearing retainer is a component made up of Galvanized iron and coated with colour coding to avoid the mix up of the retainers with the other similar looking parts of the propeller shaft.

The graph is plotted against the number of bearing retainer assembly for testing Vs Bearing retainer fitment results for Ok, Rework and Not ok Jobs during the trial.

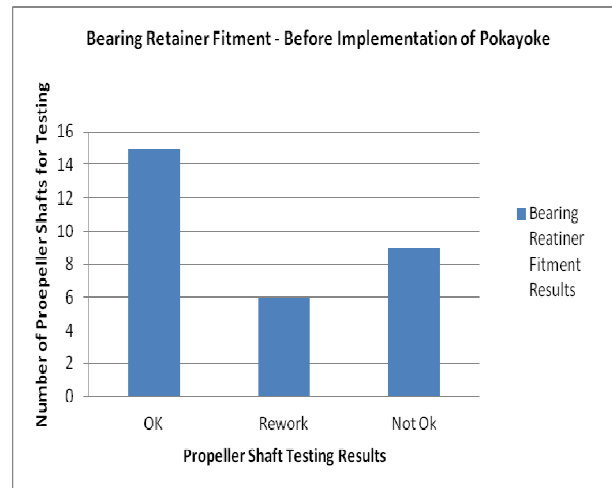


Figure 3: Bearing Retainer Fitment – Befor Implementation of the Pokayoke

By the random sampling and from the graph it is clear that there will a vast demand of the mistake proofing mechanism, which will lead a better productivity and throughput to perform the mistake proofed bearing retainer operation. The bearing retainer operation station was mainly troubling with the following defects;

- The physical dimensions were distracting during the operation.
- The orientation of the notch of the upper and the bottom retainer not matching in the one axis.
- Absence of the fool proof mechanism, which will ensure correct operation.
- The retainer will be loosening out after the operation.

The data are collected and sorted the components along with the above defects concerning to the bearing retainer operation. After finding out the defects during bearing retainer fitment; trials arranged to watch the pattern of failure.

Trial Details

- Number of bearing retainer assembly considered for the trial- 700 Nos.
- Number of Defects considered for the trial – 04

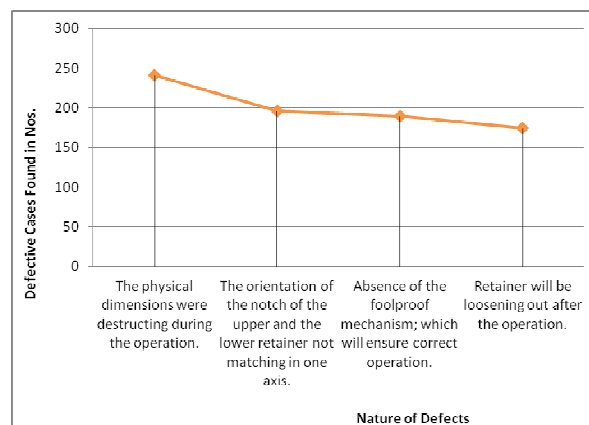


Figure 4: Nature of defects Vs Defective Cases Found in Nos.

Inferences from the Graph;

- The defective “physical dimensions were distracting during the operation” have a more contribution in the bearing retainer assembly is.
- The defective “orientation of the notch of the upper and the lower retainer not matching in one axis” has a contribution of 196 out of 700 samples.
- The defective “absence of the fool proof mechanism; which will ensure correct operation” has a contribution of 189 out of 700 samples.
- The defective “retainer will be loosening out, after the operation” pays an attention as this is the most serious safety issue.

The bearing retainer operation is mainly manual operation. All the processes; starting from the retainer selection for the assembly have been carried out manually. There is an absence of the most of the modern manufacturing technologies; the main reason is that there is tremendous production loads given by the production planning and control department.

All the times the production supervisors and the production offices are fully loaded of the propeller shaft assembly. And there is a very little time, which is left with these peoples to work on these kinds of quality issues. The quality along with the quantity has a prime importance; but for maintaining the quality at this current setup, there is a huge amount of the waste; which is getting accumulated on and off the production line; which is a severe concern and one of the main hurdle in achieving the optimum production [2] and the throughput.

DESIGN PHASES FOR MODIFICATION OF BEARING RETAINER FITMENT OPERATION

Phase I- Ishikawa Analysis

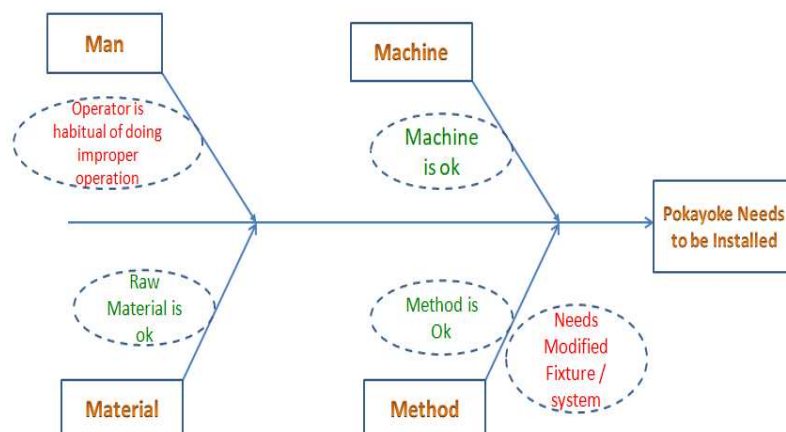


Figure 5: Ishikawa Analysis

From the Ishikawa analysis it is clear that,

- To modify the existing fixture with some fool proof system to ensure the operator's mistakes, i.e. to install the “Pokayoke” over the operating station.

- Associates are mostly habitual of doing an improper operation; proper training with the instructions, i.e. standardized operating procedures must be given to the associates.
- The Hydraulic machine functions satisfactorily. The alignment is up to the mark. No need to play with the machine parameters.
- Raw materials, i.e. “Retainers” are also ok. They are checked by quality department before supplying to the bearing retainer press up station.

Phase II- Design Study of Bearing Retainer

The bearing retainer is an important component of the propeller shaft; manufactured with Galvanized iron. The bearing retainer has an internal diameter lesser than the external diameter of the bearing.

CAD 2D Model of Bearing Retainer

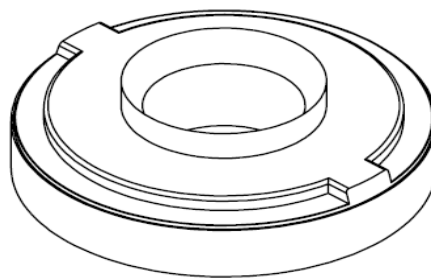


Figure 6: CAD 2D Drawing of Bearing Retainer (Side View)

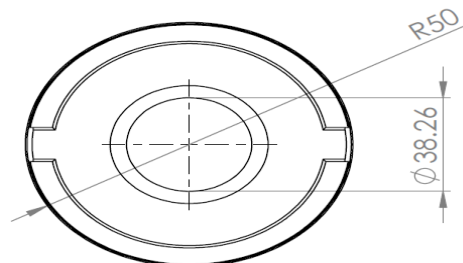


Figure 7: CAD 2D Drawing of Bearing Retainer (Top View)

CAD 3D model of Bearing Retainer



Figure 8: CAD 3D Model of Bearing Retainer

Phase III- Study of Bearing Retainer Fitment Set up

The bearing retainer will be pressed over the bearing. The figure shows the schematic representation of the bearing retainer fitment operation over hydraulic press.

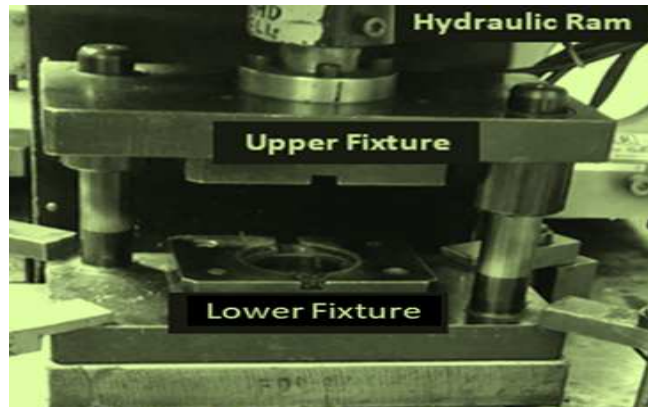


Figure 9: Bearing Retainer fitment Fixture (Courtesy: MSL)

The figure shows the schematic representation of the bearing retainer fitment set up. The machine used is a hydro-pneumatic ram type. The machine consists of the table, ram, electric control panel and the special purpose fixture of the bearing retainer. The fixture divided into two halves; the upper part and the lower part of the fixture. The upper part of the fixture is guided by the two cylindrical dowel shafts. The location of the guides is placed exactly opposite to each other.

Bearing Retainer Fixture - 2D Drawing

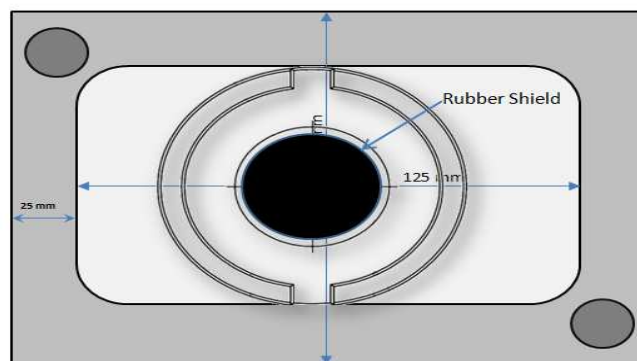


Figure 10: Bearing Retainer Fixture 2D (Upper Fixture)

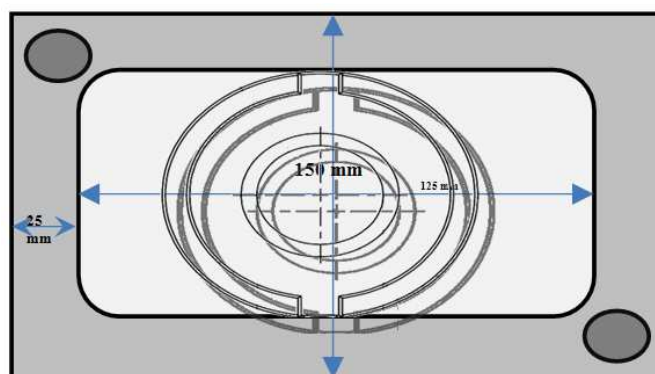


Figure 11: Bearing Retainer Fixture 2D (Lower Fixture)

Loop Hole's identified in the fixture

- During working operator is placing the retainer on lower fixture, but no mechanism is present there to give feedback that whether the retainer sitting properly in the desired cavity or not.
- The operator is starting the operation cycle by pressing the foot pedal and simultaneously doing the job of assembly may lead to severe accident on the machine.

Phase IV- Preparation of Process Layout for Designing the Pokayoke

After detail study of the problem definition; it is decided to implement the defect elimination type of Pokayoke system over the bearing retainer press up station. The process layout is prepared; considering the detailing of the process parameters.

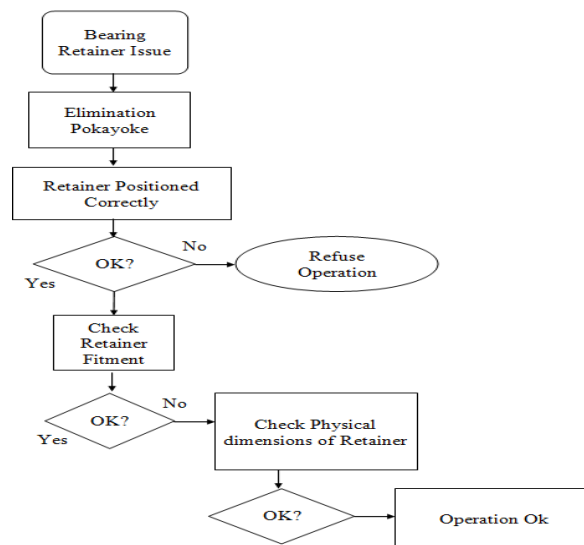


Figure 12: Pokayoke Implementation Process Layout

Bill of Material

For designing and installing the Pokayoke the following components were used;

- Proximity Sensor
- Inductive Proximity Sensor
- M-18 PNP No/ Flush
- Range -5 mm
- DC 3 Wires
- Proxy Sensor Mounting Clamps
- Control Unit
- Feedback Wirings
- Light Display System

PROPOSED LAYOUT OF POKAYOKE; FOR IMPLEMENTATION ON BEARING RETAINER FITMENT STATION

Type I Layout

In this proposed Layout (Type –I) of Pokayoke for Implementation on bearing retainer fitment station the two set of the proximity sensors or most commonly it is called as proxy sensors; are used. The logic used to use the proximity sensor is to detect the presence of the notch of the retainer when it is fixed over the upper fixture.

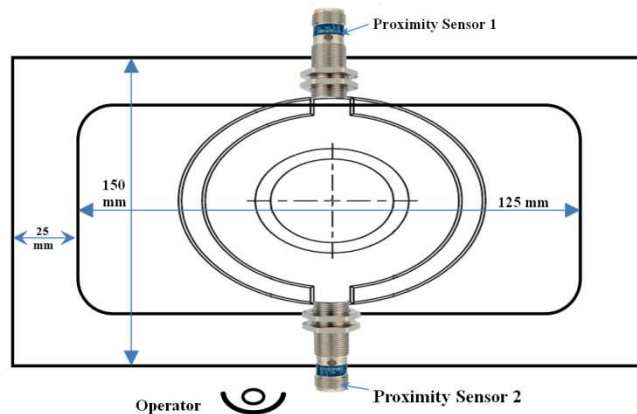


Figure 13: Proposed Pokayoke “Type I” for Bearing Retainer Fitment Operation

Earlier it was missing, the position finalized to locate the sensors in the upper fixture. The solution for the implementation of the Type-I Pokayoke was communicated to the senior manager- production; memorandum is made from the detail discussion are as follows,

- If we could provide the proximity sensors, it would be difficult for the maintenance department personals for the synchronization of both the proximity sensors in the old machine control unit.
- If we can use; only one proximity sensor to detect the physical appearance of the retainer the location of the proximity sensor must not be heading towards to the operator. The main reason is not to obstruct the operator and also it may be a concern to the EOHS audit.
- The operation must be carried out by the foot switch, but during the operation over the Hydro-Pneumatic Press for the safety to the operator must be given priority.
- The light curtain or such kind of the safety firewall must be incorporated into the operation setup.
- The new suggested Pokayoke must not require any additional power source out of whatever the power which is available in the propeller shaft assembly itself.
- The Pokayoke must not create any barrier in changing the fixture.

It was decided to design the Pokayoke system with one sensor only. The Type-II proposal is same as compared to the Type-I system; the only major difference is of number of Proximity sensors used and the layout of the location of the proximity sensor.

Type II Layout

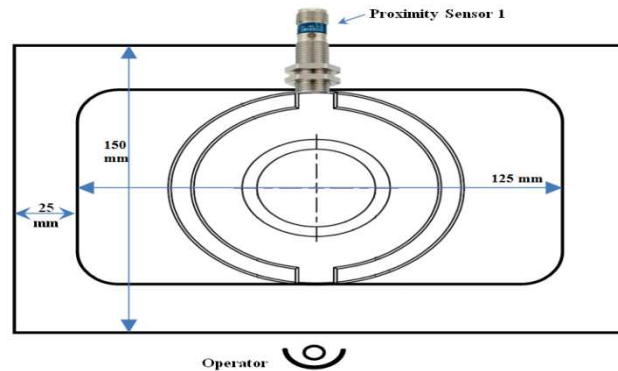


Figure 14: Proposed Pokayoke “Type II” for Bearing Retainer Fitment Operation

After implementation of the Pokayoke trials were initiated for the random sampling of the bearing retainer fitment operation.

Trial Details

- Number of Propeller Shafts Considered for trial – 60 Nos.
- Series of the Propeller Shaft considered for trial – 1310 and 1350
- Shift Considered – Random
- Operator considered for the trial is variable.
- The bearing retainers considered for the trial are 100% inspected.

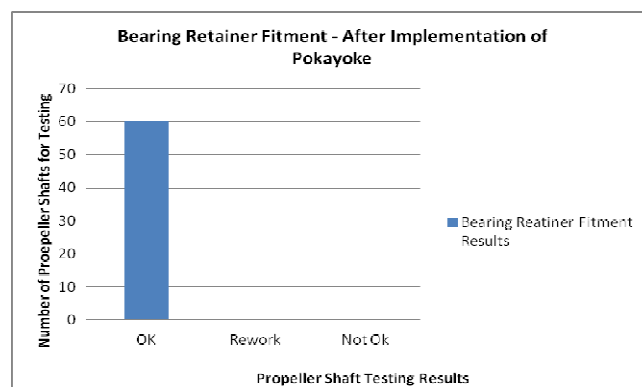


Figure15: Bearing Retainer Fitment Data (Post Pokayoke)

Results

- Productivity Optimization achieved is – 50 %.
- A reduction in “Rework” jobs of the propeller shaft is – 20 %
- A reduction in “ Not Ok” jobs of the propeller shaft is – 30 %

CONCLUSIONS AND FUTURE SCOPE

Propeller Shaft is very crucial component of an automobile, its manufacturing process is very much significant and at some stages it will be even critical and specific. If any little mistake happened or defect may remained during the manufacturing the propeller shaft, it may lead to a severe mishap during when the vehicle is running. Pokayoke plays a vital role in the overall manufacturing process of the propeller shaft. It serves the purpose of eliminating the human mistakes which may be causing during the actual process. “Pokayoke is really Game changer tool in Propeller Shaft Assembly”.

Though this Pokayoke is implemented on bearing retainer fitment operation; there is still scope for implementation of the Prevention type and Detection type Pokayoke in diverse sections of propeller shaft assembly section.

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